Filed Claims / Rule 126 - Renumbering Claims

WHAT IS CLAIMED IS:

1. A recycled thermoplastic resin, comprising:

about 20 to about 99.9 parts by weight of one or more polymers of a primary polymer type;

about 0.1 to about 40 parts by weight of residual additives; and

one or more polymers of one or more secondary polymer types that are dissimilar to the primary polymer type, the one or more polymers of secondary polymer types including one or more of from 0 to about 79 parts by weight of one or more polymers of one or more secondary polymer types that are compatible with the first polymer type and/or from 0 to about 40 parts by weight of one or more polymers of one or more second polymer types that are incompatible with the first polymer type.

2. The resin of claim 1, wherein:

the polymers of the primary polymer type and/or the secondary polymer types include two or more grades of polymers.

3. The resin of either of claims 1 or 2, wherein:

the two or more grades of polymers are characterized by different molecular weights, different molecular composition or different polymer structure.

4. The resin of any of claims 1-3, wherein:

the two or more grades of the polymers are derived from different manufacturers.

5. The resin of any of claims 1-4 wherein:

one or more of the polymers of the primary and/or secondary polymer types exhibits detectible oxidation resulting from aging.

6. The resin of any of claims 1-5, wherein:

the residual additives include bromine and antimony, where the ratio of bromine to antimony is between about 1:1 and 10:1, and the bromine and the antimony are present at combined levels of about 1 ppm to about 5% by weight.

7. The resin of any of claims 1-6, wherein:

the residual additives include titanium dioxide at levels between about 0.5% by weight and about 5% by weight.

8. The resin of any of claims 1-7, wherein:

the residual additives include carbon black at levels between about 0.1% by weight and about 3% by weight.

9. The resin of any of claims 1-8, wherein:

the residual additives include one or more additional pigments or organic dye colorants at levels between about 1 ppm by weight and about 0.1% by weight.

10. The resin of any of claims 1-9, wherein:

the residual additives include two or more elements selected from the group consisting of Cd, Pb, Hg, Cr and Ni, the one or more elements being present at levels between about 0.1 ppm and 100 ppm.

11. The resin of any of claims 1-10, wherein:

the residual additives include one or more additives selected from the group consisting of antioxidants, heat stabilizers, UV stabilizers, flame retardants, antistatics, blowing agents, impact modifiers, compatibilizers, fillers, fiber reinforcements, fluorescent whiteners, and lubricants.

12. The resin of any of claims 1-11, wherein:

the residual additives include two or more inconsistent residual additives

13. The resin of any of claims 1-12, wherein:

the compatible dissimilar polymers are included in the product composition in controlled amounts to meet user selected property requirements.

14. The resin of any of claims 1-13, wherein:

the incompatible dissimilar polymers are included in the product composition in controlled amounts to meet user selected property requirements.

15. The resin of any of claims 1-14, wherein:

the aging of the primary polymer type and/or the secondary polymer types is detectible by infrared spectroscopy.

16. The resin of any of claims 1-15, wherein:

the one or more polymers of the primary polymer type include an impact modified styrene acrylonitrile copolymer that comprises about 80 to about 99 parts by weight of the resin;

a first polymer of the one or more secondary polymer types is a styrene acrylonitrile copolymer that comprises about 0 to about 19 parts by weight of the resin; the residual additives comprise about 2 to about 7 parts by weight of the resin;

a second polymer of the one or more secondary polymer types comprises about 0 to about 7 parts by weight of the resin; and wherein

the resin further comprises a rubber comprising between about 5% by weight and 30% by weight of the resin and has a glass transition temperature between about 105° C and about 110°C.

17. The resin of claim 16, wherein:

the rubber includes a butadiene polymer rubber; and

the first or second polymer of the one or more secondary polymer types is a high impact polystyrene, a general purpose polystyrene, a polyolefin, a polyurethane, a nylons, a polyphenylene ether, a polycarbonate, a polyethylene terephthalate or a polybutylene terephthalate.

18. The resin of claim 17, wherein the resin has the following properties:

a density of about 1.06 to about 1.10 grams per cubic centimeter, as determined by ASTM D 792;

a melt flow rate of about 2 to about 9 grams per 10 minutes, as determined by ASTM D 1238;

a tensile stress at yield of about 36 to about 48 MPa, as determined by ASTM D 638; and

a notched Izod impact (3.2 mm notch) of about 85 to about 200 Joules per meter, as determined by ASTM D 256.

19. The resin of any of claims 16-18, wherein:

one or more of the polymers of the primary or secondary polymer types are an impact modified styrene acrylonitrile copolymer, a blend of polycarbonate with an impact modified styrene acrylonitrile copolymer, a copolymer blend of styrene acrylonitrile and acrylate polymers, a polysulfone, a copolymer of styrene and acrylonitrile, polycarbonate, polyvinyl chloride, or polyurethane.

20. The resin of any of claims 16-18, wherein:

a second polymer of the one or more secondary polymer types includes polystyrene, an impact modified polystyrene, a polyolefin, a polyurethane, a nylon, polyphenylene ether, polycarbonate, polyethylene terephthalate or polybutylene terephthalate.

21. The resin of any of claims 16-18, wherein:

at least one polymer of the one or more primary polymer types is an impact modified styrene acrylonitrile copolymer; and

at least one polymer of the one or more secondary polymer types is a HIPS polymer, where the HIPS polmer is present in the resin in a substantial amount to achieve a user selected notched izod impact strength.

22. The resin of any of claims 1-15, wherein:

the one or more polymers of the primary polymer type includes an impact modified styrene polymer that comprises about 70 to about 99 parts by weight of the resin;

a first polymer of the one or more secondary polymer types is a general purpose polystyrene that comprises about 0 to about 10 parts by weight of the resin;

the residual additives comprise about 1 to about 5 parts by weight of the resin;

a second polymer of the one or more secondary polymer types comprises 0 to about 7 parts by weight of the resin; and

the resin further comprises between about 8% by weight and 16% by weight of a rubber and has a glass transition temperature between about 96° C and about 100°C.

23. The resin of claim 22, wherein:

the rubber includes a butadiene polymer rubber; and

the second polymer of the one or more secondary polymer types is an acrylonitrile butadiene styrene terpolymer, polyolefin, polyurethane, a nylon, polyphenylene ether, or polycarbonate.

24. The resin of either of claims 22 or 23, further comprising:

a styrene portion of the polymer having a degradation temperature between about 400°C and 405°C.

25. The resin of any of claims 22-24, wherein the resin has the following properties:

a density of about 1.04 to about 1.08 grams per cubic centimeter, as determined by ASTM D 792;

a melt flow rate of about 2 to about 8 grams per 10 minutes, as determined by ASTM D 1238;

a tensile stress at yield of about 20 to about 27 MPa, as determined by ASTM D 638; and

a notched Izod impact of about 60 to about 120 Joules per meter, as determined by ASTM D 256.

26. The resin of any of claims 1-15, wherein:

the one or more polymers of the primary polymer type includes a polypropylene that comprises about 88 to about 99 parts by weight of the resin;

a first polymer of the one or more secondary polymer types comprises 0 to about 5 parts by weight of the resin;

the residual additives comprise about 1 to about 5 parts by weight of the resin;

a second polymer of the one or more secondary polymer types comprises 0 to about 7 parts by weight of the resin; and

the resin has distinct melting points at about 125°C and at about 164°C and crystallization temperatures at about 110°C and at about 130°C.

27. The resin of claim 26, wherein:

the polymers of the one or more secondary polymer types include an acrylonitrile butadiene styrene terpolymers, polystyrene, an impact modified polystyrene, or polyethylene.

28. The resin of any of claims 26-27, wherein the resin has a degradation temperature of about 430°C.

29. The resin of any of claims 26-28, wherein said resin has the following properties:

a density of about 0.92 to about 0.96 grams per cubic centimeter, as determined by ASTM D 792;

a melt flow rate of about 20 to about 30 grams per 10 minutes, as determined by ASTM D 1238;

a tensile stress at yield of about 20 to about 28 MPa, as determined by ASTM D 638; and

a notched Izod impact (3.2 mm notch) of about 50 to about 100 Joules per meter, as determined by ASTM D 256.

30. The resin of any of claims 1-15, wherein:

the one or more polymers of the primary polymer type include a polycarbonate that comprises about 20 to about 98 parts by weight of the resin;

a first polymer of the one or more secondary polymer types comprises 0 to about 93 parts by weight of an impact modified styrene acrylonitrile copolymer;

the residual additives comprise about 2 to about 10 parts by weight of the resin;

a second polymer of the one or more secondary polymer types comprises 0 to about 10 parts by weight of the resin; and

the resin has distinct melting points at about 125°C and at about 164°C and crystallization temperatures at about 110°C and at about 130°C.

31. The resin of any of claims 1-30, wherein:

the resin is in the form of a flake having a size of about 1 mm to about 8 mm.

32. The resin of any of claims 1-31, wherein:

the recycled thermoplastic resin is recovered from a waste plastic material derived from one or more post consumer sources selected from the group consisting of office automation equipment, white goods, consumer electronics, automotive shredder residue, packaging waste, household waste and building waste and post industrial molding and extrusion scrap.

33. A pellet extruded from the resin of any of claims 1-32.

34. A sheet extruded from the resin of any of claims 1-32.

35. An article prepared by the co-extrusion of the resin of any of claims 1-32 and one or more polymers selected from the group consisting of impact modified styrene acrylonitrile copolymer, blends of polycarbonate with an impact modified styrene acrylonitrile copolymer, copolymer blends of styrene acrylonitrile and acrylate polymers, polysulfone, copolymers of styrene and acrylonitrile, polycarbonate, polyvinyl chloride, polyurethane, high impact styrene copolymers and polyolefins.

36. A method of preparing a recycled thermoplastic material, the method comprising:

selecting one or more waste plastic materials based on the sources of the waste plastic materials; and

combining the selected waste plastic materials to achieve a recycled plastic material having one or more predetermined properties.

37. The method of claim 36, wherein:

selecting one or more waste plastic materials includes selecting waste plastic materials based on a geographic source.

38. The method of claim 37, wherein:

the geographic source is a country of product production.

39. The method of claim 37, wherein:

the geographic source is North America, Europe, or Asia.

40. The method of any of claims 36-39, wherein:

selecting one or more waste plastic materials includes selecting a waste plastic material from a source consisting of office automation equipment, white goods, consumer electronics, automotive shredder residue, packaging waste, household waste and building waste and post industrial molding and extrusion scrap.

41. The method of any of claims 36-40, wherein selecting one or more waste plastic materials includes selecting one or more waste plastic materials to yield a recycled plastic material comprising:

about 20 to about 99.9 parts by weight of polymer of a primary polymer type;

about 0.1 to about 40 parts by weight of residual additives; and

0 to about 79 parts by weight of one or more polymers of one or more secondary polymer types that are compatible with and dissimilar from the primary polymer; and

0 to about 40 parts by weight of one or more polymers from one or more secondary polymer types that are incompatible with and dissimilar from the primary polymer type.

42. A method of preparing a recycled plastic material, the method comprising:

providing waste plastic material;

separating the waste plastic material into a plurality of homogenous plastic materials;

determining amounts of at least one of the plurality of homogenous plastic materials and at least one other plastic material to provide one or more predetermined properties of a recycled plastic material; and

combining the at least one of the plurality of homogenous plastic materials and the at least one other plastic material in the determined amounts to provide a recycled plastic material.

43. The method of claim 42, wherein:

the at least one other plastic material is a selected from the plurality of homogenous plastic materials.

44. The method of claim 42, wherein:

the at least one other plastic material is a virgin plastic material.

45. The method of any of claims 42-44, wherein:

at least two of the homogenous plastic materials include a different primary polymer type.

46. The method of any of claims 42-45, wherein:

at least two of the homogenous plastic materials include the same primary polymer type and are distinguishable from one another based on one or more properties of the homogenous plastic material.

47. The method of any of claims 42-46, wherein:

the homogeneity of the homogenous plastic materials is determined at least in part by the source of the waste plastic material.

48. The method of any of claims 42-47, wherein:

the homogeneity of the homogenous plastic materials is determined at least in part by a separating process used to separate the waste plastic material.

49. The method of any of claims 42-48, further comprising:

compounding an additive or a polymer with the recycled plastic material.

50. The method of any of claims 42-49, wherein:

determining amounts includes determining amounts of a first type of ABS material and a second type of ABS material that can be combined to form a recycled plastic material having a notched izod impact strength higher than the notched izod impact strength of the first type of ABS.

51. The method of any of claims 42-49, wherein:

determining amounts includes determining amounts of a first type of ABS material and a second type of ABS material that can be combined to form a recycled plastic material having a notched izod impact strength higher than the notched izod impact strength of either the first type of ABS material or the second type of ABS material.

52. The method of any of claims 42-49, wherein:

determining amounts includes determining amounts of an ABS material and a HIPS material that can be combined to form a recycled plastic material having an increased tensile strength relative to a tensile strength of the HIPS material.

53. The method of any of claims 42-49, wherein:

determining amounts includes determining amounts of a modified PPO material and a HIPS material that can be combined to form a recycled plastic material having an increased notched izod impact strength and tensile strength and decreased melt flow rate relative to the HIPS material.

54. The method of any of claims 42-49, wherein:

determining amounts includes determining amounts of an ABS material and a PC material that can be combined to form a recycled plastic material having an increased notched izod impact strength and tensile strength relative to the ABS material.

55. The method of any of claims 42-49, wherein:

determining amounts includes determining amounts of an ABS material and a regrind flame retarded PC material that can be combined to form a recycled plastic material having an increased tensile strength relative to the ABS material.

56. The method of any of claims 42-49, wherein:

determining amounts includes determining amounts of an ABS material and a PC/ABS material that can be combined to form a recycled plastic material having an increased notched izod impact strength and tensile strength relative to the ABS material.

57. The method of claims 42-49, wherein:

determining amounts includes determining amounts grades of ABS materials to form a recycled plastic material with a predetermined SAN content.

58. The methods of claims 57, wherein:

the predetermined SAN content is sufficient to achieve one or more predetermined property, the properties including one of environmental stress crack resistance, tensile strength, impact strength, melt flow rate of the recycled plastic material.

59. A method of preparing a plastic material, comprising:

combining a resin of any of claims 1-30 with one or more polymers of a tertiary polymer type, where the polymers of the tertiary polymer type comprise between less

than 1 part by weight to more than 99 parts by weight of the plastic material and the polymers of the tertiary polymer type are compatible with the resin.

60 61. The method of claim 59, wherein:

the polymers of the primary polymer type include polypropylene and the polymers of the tertiary polymer type include a polypropylene, a low density polyethylene or another polymer with which polypropylene is compatible.

61 62. The method of claim 59, wherein:

the polymers of the primary polymer type include polycarbonate and the polymers of the tertiary polymer type include a polycarbonate, PC/ABS, a acrylonitrile butadiene styrene terpolymer, an acrylonitrile styrene acrylate copolymer or another polymer with which polycarbonate is compatible.

62 63. The method of claim 59, wherein:

the polymers of the primary polymer type include HIPS and the polymers of the tertiary polymer type include an impact modified styrene polymer, a general purpose polystyrene, a modified polyphenylene ether or another polymer with which HIPS is compatible.

63 64. A recycled plastic material made by any one of methods 36-62.

64 65. A method of determining whether a plastic material has been formed from waste plastic materials, comprising:

determining whether detectible amounts of compounds of bromine or antimony are present in a plastic material in sufficient quantities to identify the resin as being derived from waste plastic material and insufficient quantities to render the plastic material flame retardant.

65 66. The method of claim 64, further comprising:

determining whether the plastic material contains an oxidized polymer using FTIR.

R. 126

66/67. The method of either claim 64/65 or 65, further comprising:

determining whether the plastic material contains oxidized antioxidant compounds.